CLAIMS

What is claimed is:

1. An apparatus, comprising:

a device having a thermal characteristic which is dependent on a number of times the device is accessed over a period of time; and

a controller connected to the device and adapted to control access to the device,

wherein the controller is adapted to calculate a temperature estimate of the device and to control access to the device in accordance with the calculated temperature estimate.

2. The apparatus of claim 1, wherein the controller is adapted to receive an access request, calculate the temperature estimate in accordance with the access request, determine if the temperature estimate exceeds a temperature threshold, and impose an access request budget if the temperature estimate exceeds the temperature threshold.

3. The apparatus of claim 2, wherein the controller is adapted to process the access request without an access request budget if the temperature estimate does not exceed the temperature threshold.

4. The apparatus of claim 2, wherein the controller is adapted to process the request in accordance with the imposed access request budget if the temperature estimate exceeds the temperature threshold.

5. The apparatus of claim 2, wherein the controller is adapted to calculate a new access request budget each time the access request budget is imposed.

6. The apparatus of claim 2, wherein the controller is adapted to calculate a new access request budget periodically.

7. The apparatus of claim 6, wherein the controller is adapted to calculate the new access request budget when a parameter involved in the calculation is updated.

8. The apparatus of claim 7, wherein the updated parameter corresponds to an ambient temperature.

9. The apparatus of claim 1, wherein the controller is adapted to calculate the temperature estimate in accordance with an estimated initial temperature of the device, an estimated equilibrium temperature of the device, and an estimated temperature decay rate for the device.

10. The apparatus of claim 9, wherein the controller is adapted to calculate the temperature estimate in accordance with the following equation:

$$T_n = T_{n-1} - \left[T_{n-1} - \left(T_a + P_{max} \cdot \theta_{ja} \cdot \frac{1/f_{request}}{\Delta_{update}} \cdot R_{count} \right) \right] \cdot \Delta_{update} \cdot \alpha \quad ;$$

where: T_n corresponds to the temperature estimate;

T_{n-1} corresponds to a previous temperature estimate;

T_a corresponds to an ambient temperature;

P_{max} corresponds to a maximum device power;

θ_{ja} corresponds to a junction-to-ambient thermal resistance

$f_{request}$ corresponds to an access request frequency (e.g. a clock rate);

Δ_{update} corresponds to an estimator update period;

R_{count} corresponds to a number of access requests granted; and

α corresponds to a decay rate.

11. The apparatus of claim 9, wherein the controller is adapted to calculate the temperature estimate in accordance with the following equation:

$$T_n = T_{n-1} - \left[T_{n-1} - \left(T_a + c_1 \cdot R_{count}\right)\right] \cdot c_2$$

where: T_n corresponds to the temperature estimate;

T_{n-1} corresponds to a previous temperature estimate;

T_a corresponds to an ambient temperature;

R_{count} corresponds to a number of access requests granted;

c_1 is a first constant; and

c_2 is a second constant.

12. The apparatus of claim 11, wherein c_1 corresponds to $(P_{max} * \theta_{ja} * 1/f_{request} / \Delta_{update})$ and c_2 corresponds to $(\Delta_{update} * \alpha)$;

where: P_{max} corresponds to a maximum device power;

θ_{ja} corresponds to a junction-to-ambient thermal resistance

$f_{request}$ corresponds to an access request frequency (e.g. a clock rate);

Δ_{update} corresponds to an estimator update period;

α corresponds to a decay rate.

13. A method, comprising:

providing a device having a thermal characteristic which is dependent on a number of times the device is accessed over a period of time;

calculating a temperature estimate of the device; and

controlling access to the device in accordance with the calculated temperature estimate.

14. The method of claim 13, further comprising:

receiving an access request;

calculating the temperature estimate in accordance with the access request;

determining if the temperature estimate exceeds a temperature threshold; and

imposing an access request budget if the temperature estimate exceeds the temperature threshold.

15. The method of claim 14, further comprising:

processing the access request without an access request budget if the temperature estimate does not exceed the temperature threshold.

16. The method of claim 14, further comprising:

processing the request in accordance with the imposed access request budget if the temperature estimate exceeds the temperature threshold.

17. The method of claim 14, further comprising:

calculating a new access request budget each time the access request budget is imposed.

18. The method of claim 14, further comprising:

calculating a new access request budget periodically.

19. The method of claim 18, the new access request budget is calculated when a parameter involved in the calculation is updated.

20. The method of claim 19, wherein the updated parameter corresponds to an ambient temperature.

21. The method of claim 13, wherein the calculating comprises calculating the temperature estimate in accordance with an estimated initial temperature of the device, an estimated equilibrium temperature of the device, and an estimated temperature decay rate for the device.

22. The method of claim 21, wherein the temperature estimate is calculated in accordance with the following equation:

$$T_n = T_{n-1} - \left[T_{n-1} - \left(T_a + P_{max} \cdot \theta_{ja} \cdot \frac{1/f_{request}}{\Delta_{update}} \cdot R_{count} \right) \right] \cdot \Delta_{update} \cdot \alpha \quad ;$$

where: Tn corresponds to the temperature estimate;

$Tn\text{-}1$ corresponds to a previous temperature estimate;

Ta corresponds to an ambient temperature;

$Pmax$ corresponds to a maximum device power;

θja corresponds to a junction-to-ambient thermal resistance

$frequest$ corresponds to an access request frequency (e.g. a clock rate);

$\Delta update$ corresponds to an estimator update period;

$Rcount$ corresponds to a number of access requests granted; and

α corresponds to a decay rate.

23. The method of claim 21, wherein the temperature estimate is calculated in accordance with the following equation:

$$T_n = T_{n-1} - \left[T_{n-1} - \left(T_a + c_1 \cdot R_{count} \right) \right] \cdot c_2$$

where: Tn corresponds to the temperature estimate;

$Tn\text{-}1$ corresponds to a previous temperature estimate;

Ta corresponds to an ambient temperature;

$Rcount$ corresponds to a number of access requests granted;

$c1$ is a first constant; and

$c2$ is a second constant.

24. The method of claim 23, wherein $c1$ corresponds to $(P_{max} * \theta_{ja} * 1/f_{request} / \Delta_{update})$ and $c2$ corresponds to $(\Delta_{update} * \alpha)$;

where: P_{max} corresponds to a maximum device power;

θ_{ja} corresponds to a junction-to-ambient thermal resistance

$f_{request}$ corresponds to an access request frequency (e.g. a clock rate);

Δ_{update} corresponds to an estimator update period;

α corresponds to a decay rate.

25. A system, comprising:

a processor;

a device; and

a controller connected between the processor and the device,

wherein the controller is adapted to calculate a temperature estimate of the device and to control access to the device in accordance with the calculated temperature estimate.

26. The system of claim 25, wherein the controller is adapted to receive an access request, calculate the temperature estimate in accordance with the access request, determine if the temperature estimate exceeds a temperature threshold, and impose an access request budget if the temperature estimate exceeds the temperature threshold.

27. The system of claim 26, wherein the controller is adapted to process the access request without an access request budget if the temperature estimate does not exceed the temperature threshold.

28. The system of claim 26, wherein the controller is adapted to process the request in accordance with the imposed access request budget if the temperature estimate exceeds the temperature threshold.

29. The system of claim 26, wherein the controller is adapted to calculate a new access request budget each time the access request budget is imposed.

30. The system of claim 26, wherein the controller is adapted to calculate a new access request budget periodically.

31. The system of claim 30, wherein the controller is adapted to calculate the new access request budget when a parameter involved in the calculation is updated.

32. The system of claim 31, wherein the updated parameter corresponds to an ambient temperature.

33. The system of claim 25, wherein the controller is adapted to calculate the temperature estimate in accordance with an estimated initial temperature of the device, an estimated equilibrium temperature of the device, and an estimated temperature decay rate for the device.

34. The system of claim 33, wherein the controller is adapted to calculate the temperature estimate in accordance with the following equation:

$$T_n = T_{n-1} - \left[T_{n-1} - \left(T_a + P_{max} \cdot \theta_{ja} \cdot \frac{1/f_{request}}{\Delta_{update}} \cdot R_{count} \right) \right] \cdot \Delta_{update} \cdot \alpha \quad ;$$

where: T_n corresponds to the temperature estimate;

T_{n-1} corresponds to a previous temperature estimate;

T_a corresponds to an ambient temperature;

P_{max} corresponds to a maximum device power;

θ_{ja} corresponds to a junction-to-ambient thermal resistance

$f_{request}$ corresponds to an access request frequency (e.g. a clock rate);

Δ_{update} corresponds to an estimator update period;

Rcount corresponds to a number of access requests granted; and

α corresponds to a decay rate.

35. The system of claim 33, wherein the controller is adapted to calculate the temperature estimate in accordance with the following equation:

$$T_n = T_{n-1} - \left[T_{n-1} - \left(T_a + c_1 \cdot R_{count}\right)\right] \cdot c_2$$

where: *Tn* corresponds to the temperature estimate;

Tn-1 corresponds to a previous temperature estimate;

Ta corresponds to an ambient temperature;

Rcount corresponds to a number of access requests granted;

c1 is a first constant; and

c2 is a second constant.

36. The system of claim 35, wherein c*1* corresponds to *(Pmax* * *θja* * *1/frequest / Δupdate)* and *c2* corresponds to *(Δupdate* * *α)*;

where: *Pmax* corresponds to a maximum device power;

θja corresponds to a junction-to-ambient thermal resistance

frequest corresponds to an access request frequency (e.g. a clock rate);

Δupdate corresponds to an estimator update period;

α corresponds to a decay rate.